13

Offshore Lebanon hydrocarbon prospectivity – what does the future hold?

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Summary

Lebanon's offshore lies within the northern Levant Basin, a geologically dynamic area adjacent to proven petroleum provinces in Israel and Cyprus. Despite its recognized hydrocarbon potential, exploration in Lebanese waters remains at an early stage, with only two exploration wells drilled to date. Much of the geological understanding relies on seismic interpretation and regional analogues.

A key enabler for future exploration is the extensive multi-client seismic database, which now covers more than 14,300 sq. km with merged 3D volumes providing superb pre-Messinian imaging. These datasets reveal structural traps, stacked reservoir intervals, and evidence of sediment input from multiple directions. Modelling also indicates the potential for mature Oligocene source rocks capable of generating hydrocarbons.

While the two initial wells did not yield discoveries, proximity to successful plays in neighbouring countries, combined with Lebanon's high-quality seismic coverage, points to significant untapped potential. With further drilling and additional seismic acquisition, offshore Lebanon remains a frontier basin that holds strong chances for future hydrocarbon discoveries.

Introduction

Lebanon's offshore domain lies within one of the most tectonically dynamic regions of the Eastern Mediterranean. Adjacent to proven petroleum provinces, the Lebanese offshore area in the northern Levant Basin has long been recognized as having significant hydrocarbon potential. However, exploration activity in this promising region has been limited to date, and several factors, including complex regional dynamics and boundary considerations, have, in the past, influenced the pace of progress toward realising its potential.

The extensive offshore acreage covers several thousand square kilometres, and two exploration wells have been drilled to date. This is in contrast to the drilling campaigns conducted in neighbouring offshore provinces such as Israel and Cyprus, where wells have proven multiple working petroleum systems. The limited well data in Lebanon means that exploration remains in an early stage, with much of the geological understanding dependent on seismic interpretation and regional analogues. From a petroleum systems perspective, offshore Lebanon's proximity to proven hydrocarbon provinces implies that similar source rock intervals, reservoir facies, and trapping mechanisms could be present.

Seismic data availability

One of the key enablers for future exploration is the extensive multi-client seismic database that has been developed following multiple seismic campaigns progressively increasing the areal coverage. Today, operators and prospective bidders have access to a combination of legacy 2D seismic lines and high-quality 3D seismic volumes covering the majority of blocks. All the 3D data have been combined into a single full stack multiclient data volume with a coverage of more than 14,300 sq.km (Figure 1). As this database has been developed over several years, some of the component surveys could be improved with reprocessing or newer acquisition where targets can be identified. Additionally, there remains the opportunity for new 3D acquisition over some areas without any existing 3D data coverage, for example the exciting acreage in the SW of the offshore over Block 8 (Figure 1) where a new survey is planned to complete the coverage.

Pre-Messinian imaging in the Lebanon offshore is generally of superb quality when compared to surrounding areas, with a deep Cretaceous marker well imaged below 10km in the deeper parts of the basin. In Egypt and Cyprus for example, the imaging is more challenging due to thicker, more deformed and compositionally complex Messinian evaporites.

Hydrocarbon prospectivity and extensions from surrounding success

With a regional 3D dataset it is possible to get an excellent understanding of not only the structural elements present in the area, which could also be obtained from regional 2D data, but also the stratigraphic elements. Isochores generated using the 3D data demonstrate the depocenter has shifted through time from the north, near the Latakia ridge, towards the southwest (Hawie et al. 2013). They also indicate that most of the sediment fill in the pre-salt sedimentary section likely originates from the Nile Delta, which is also thought to be the source of the Mid-Lower Miocene Tamar turbidite sands that host many of the clastic discoveries and fields to the south and southwest.

Within the merged 3D data, there is also clear evidence from attribute extractions for sediment input from the northeast and east at the upper Miocene level, providing an encouraging additional target reservoir in the area (also highlighted by Ghalayini et al. 2018).

In terms of structure in the pre-salt Oligo-Miocene section, there are many faulted fold structures. The folds typically have a NE-SW orientation, and the faulting is largely NW-SE. These afford explorationists many clear structural trapping mechanisms and the opportunity for stacked reservoir intervals. The faulting may also provide migration pathways for hydrocarbons. Modelling suggests that an Oligocene source rock could be mature and expelling oil from Messinian times to recent, while the nearby fields in Israel (e.g. Karish) and Cyprus have proven both a biogenic and thermogenic gas source.

There is very little public information about the two offshore exploration wells that have been drilled (Byblos-1 & Qana-1). Neither well was classed as a discovery, however these results should not deter explorers. Both wells were located in the inboard half of the Lebanon offshore (Figure 1), where reservoir sands are likely thinner and potentially further from any mature thermogenic source.

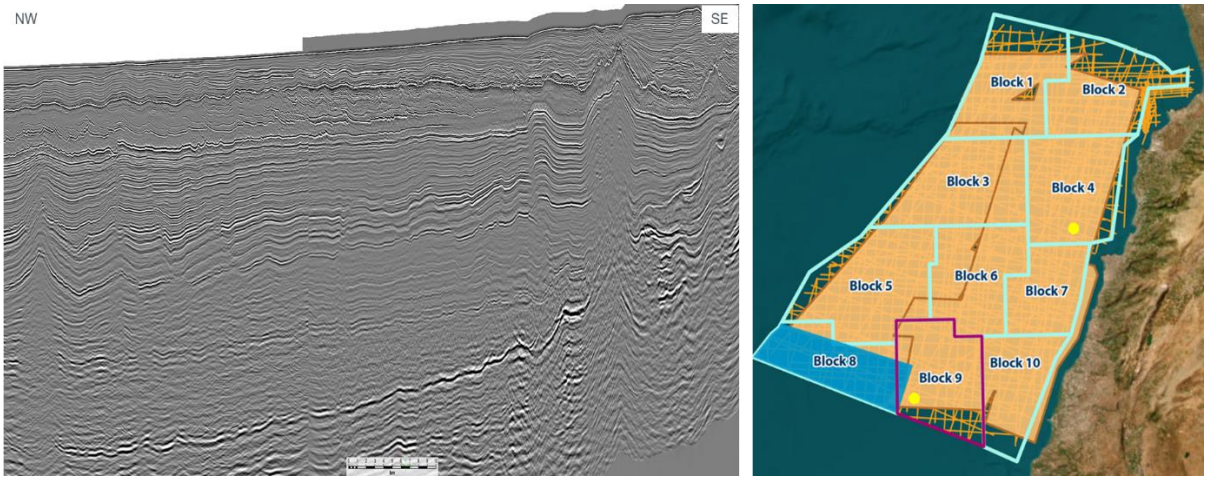

Figure 1 *On the left is a 90 km long full stack seismic section through the two 3D volumes currently being merged. The section clearly highlights some promising anticlinal structures and faulting in the pre-salt Oligo-Miocene section. The map shows current blocks (blue = available, purple = held acreage). The orange filled area indicates the existing 3D seismic data coverage. The blue filled area highlights an area earmarked for future 3D seismic acquisition. The two yellow dots indicate the location of the Byblos-1 (northern) and Qana-1 (southern) wells.*

Conclusions

With all the required petroleum systems elements proven in such close proximity, as well as additional untested potential identified, it would be surprising if there are not discoveries made in the Lebanon offshore in future.

Acknowledgements

We would like to thank the Ministry of Energy and Water in Lebanon, and the Lebanese Petroleum Administration, (our government partners), for their continued support and collaboration, as well as our TGS colleagues who worked together on the projects described in the text.

References

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